HYDROTHERMAL CONVERSION OF LIGNITE FLY ASH INTO SYNTHETIC ZEOLITE


*School of Environmental Engineering, Technical University of Crete, 73100 Chania, Greece
**School of Mineral Resources Engineering, Technical University of Crete, 73100 Chania, Greece

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The purpose of this study was to convert fly ash from lignite combustion into synthetic zeolite by hydrothermal process. The experiments were carried out using raw and washed fly ash with 5 N hydrochloric acid. Several process parameters were studied such as the solid to liquid ratio (S/L), the silica to aluminum oxide ratio (SiO$_2$/Al$_2$O$_3$), the content of calcium oxide (% CaO), the time (t) and the temperature (T) of the hydrothermal process. The experimental processing stages are presented in Fig. 1.

Fractional factorial experimental design was applied to plan the experiments. In a series of 17 experiments, the fly ash was mixed with caustic soda (NaOH) and the solution was hydrothermally processed to form the crystalline structure. Mineralogical analysis was performed by X-ray diffractometer (XRD) in order to detect zeolite formation. The results revealed the formation of four types of zeolite crystals. The washed fly ash presented the best results, i.e., the maximum zeolite yield was demonstrated when the fly ash hydrothermally treated for 6 h at 150 °C, the S/L was 1:2 and SiO$_2$/Al$_2$O$_3$ was 6.3. It was found that the zeolite Phillipsite was synthesized at 27%, while Gobbinsite (3%), Chabazite (4%) and Heulandite (4%) were also formed. According to the Pareto analysis, the temperature was the most important parameter for the synthesis of crystal zeolites, followed by the hydrothermal processing time. In conclusion, the zeolite synthesis is a rather complex process that depends on many factors, and the formation of a single zeolite using raw lignite fly ash is challenging.

Figure 1. Experimental processing stages.